VISION AND VISUAL ILLUSIONS IN FLIGHT

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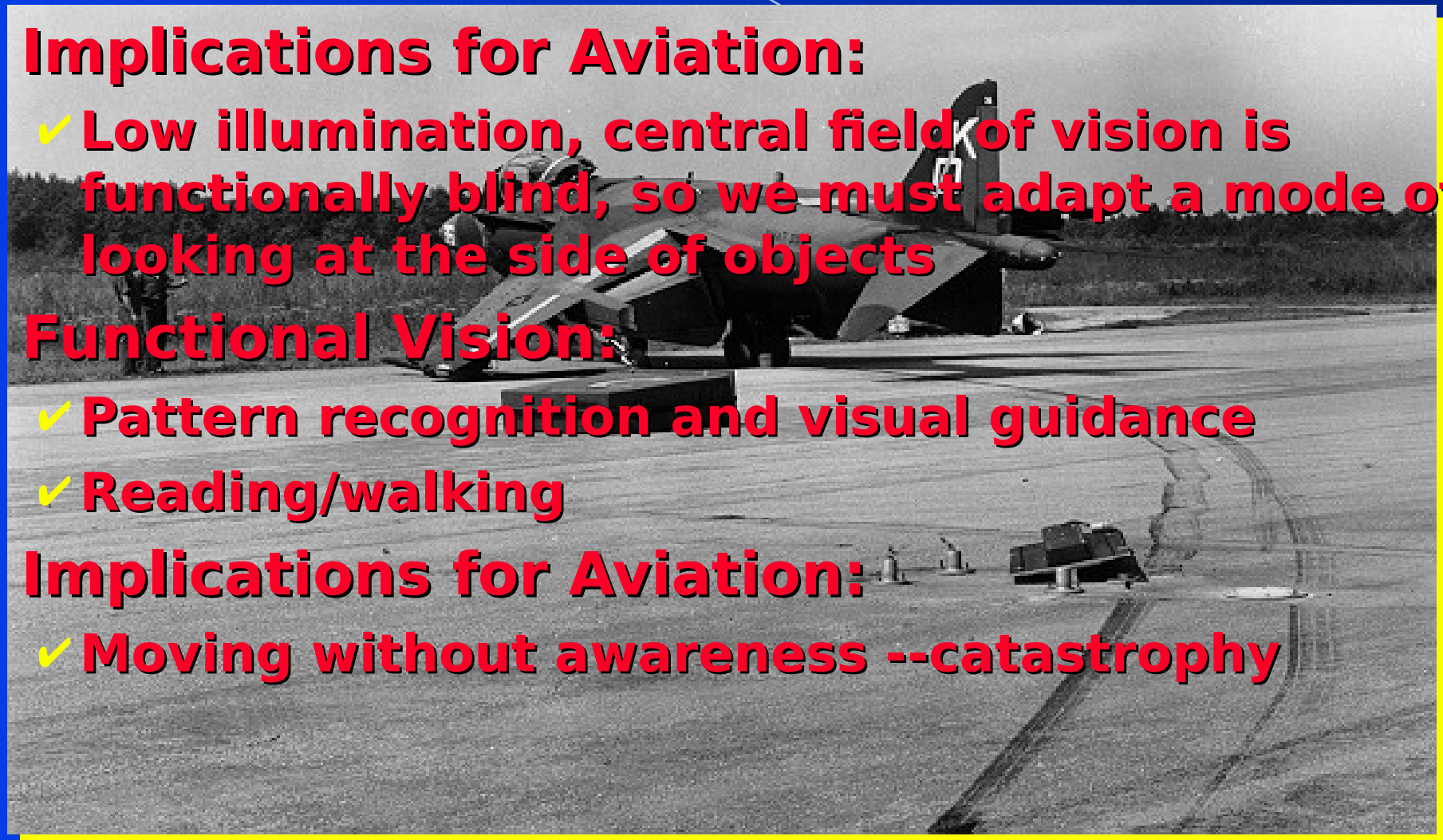
The Human Eye

- Anatomical Vision: Duplicity Theory
  - Cones and Rods
- Cones
  - Daylight vision
  - Detailed high resolution
  - Color vision
  - Motion detection
  - Fovea for central vision

The Human Eye

- Rods
  - Nighttime vision
  - Poor detail
  - Insensitive to color
  - Poor motion detection
  - Peripheral vision
- At night, utilize rods by looking at dimly lit objects approx. one hand width away from them

The Human Eye in Aviation



- **Implications for Aviation:**
  - Low illumination, central field of vision is functionally blind, so we must adapt a mode of looking at the side of objects
- **Functional Vision:**
  - Pattern recognition and visual guidance
  - Reading/walking
- **Implications for Aviation:**
  - Moving without awareness --catastrophy

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Human Visibility

- Visibility: how well human eye can see
- Contrast is key factor
- Implications for aviation:
  - Ability to recognize hazards is degraded
  - Ability to steer unaffected
- “Black Hole” approaches at night:
  - Area under aircraft dark, featureless
  - Pilots overestimate altitude, fly too low
  - AWARENESS!

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Vision and Midair Collisions

- See and Avoid Principle
- Three most common mid-air collisions:
  - Head on
  - Converging from side
  - Climb/descent
- Examples of midairs due to visual limitations

Distance Perception

- Binocular Cues
  - Convergence/Divergence, Retinal Disparity
- Monocular Cues
  - Size and shape, Linear Perspective
  - Relative Motion, Interposition
  - Light and Shadow

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Visual Illusions

- Misinterpretation of sensory data
- Unavoidable during ambiguous, obscured or absent visual cues
- AUTOKINESIS
  - Static light appears to move when stared at in the dark; reduced by visual scanning

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Visual Illusions

- RELATIVE MOTION
  - Mistake another aircraft's movement for own
- FALSE HORIZON
  - Cloud formations may be confused with horizon or ground
- GROUND-LITE MISINTERPRETATION
  - Confusion of ground lights with stars

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Visual Illusions

- WATERFALL EFFECT
  - Rotor downwash gives false cue of climb
- HEIGHT ILLUSION
  - Flying over low contrast, illusion of high alt
- FLICKER VERTIGO
  - Flicker between 4-20 cycles/sec
- SIZE-DISTANCE ILLUSION
  - Viewing light as changing in brightness

Dark Adaptation

- Sensitivity to light is impaired after periods of bright light exposure
- Depends on time for receptors to bleach
  - Dark to light: 50% recovery in 90 s
  - Light to dark: Up to 40 minutes
- Under low levels of illumination, more subject to illusions

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Human Vision

- **PHOTOPIC VISION**
  - **High levels of illumination, both rods and cones are activated**
- **SCOTOPIC VISION**
- **Low levels of illumination, cones are inactive and vision is accomplished by rods**
- **Purkinge Effect: shift from photpic to scotopic vision**

Effects of Lighting on Performance

- **GLARE:**
  - **Direct Glare: light sources in field of view**
  - **Reflected Glare: reflected by surface in field of view**
  - **Discomfort Glare: produces discomfort, but does not necessarily interfere with performance**
  - **Disability Glare: reduces performance**
  - **Blinding Glare: no object can be seen**

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Spatial Disorientation

- **SPATIAL DISORIENTATION**
  - **Mismatch of visual, vestibular, and somatosensory cues**
- **DISORIENTATION EFFECTS FROM FALSE SENSATIONS:**
  - **Post-rotatory nystagmus/Graveyard spin**
  - **Cross-coupling/Coriolis effect**
  - **Occulogravic illusion**

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